

WHAT IS CLAIMED IS:

1. A method of making a sodium zirconium carbonate comprising heating a mixture of zirconium oxychloride and soda ash at a sufficient temperature and for a sufficient time to form said sodium zirconium carbonate.

5 2. The method of claim 1, further comprising, prior to said heating, agitating the zirconium oxychloride and soda ash to form a solution mixture at ambient temperature.

3. The method of claim 1, wherein said soda ash is in the form of an aqueous slurry or solution.

4. The method of claim 1, wherein said zirconium oxychloride and soda ash are
10 present in a weight ratio of from about 3.0:1 to about 4.0:1.

5. The method of claim 4, wherein said weight ratio is from about 3.5:1 to about 4.0:1.

6. The method of claim 4, wherein said weight ratio is about 3.6:1.

7. The method of claim 1, wherein said zirconium oxychloride is in the form of
15 a powder or solution.

8. The method of claim 1, wherein said sufficient temperature is the boiling temperature of the mixture of zirconium oxychloride and soda ash.

9. The method of claim 8, wherein the heating occurs for about 2 hours.

10. The method of claim 1, wherein said temperature is from about 150 °F to
20 about 250 °F.

11. The method of claim 1, further comprising, after said heating, filtering off the sodium zirconium carbonate.

12. The method of claim 11, further comprising, after filtering, washing any chloride or any impurities from said sodium zirconium carbonate.

13. The method of claim 1, further comprising, after heating, titrating an alkaline slurry comprising said sodium zirconium carbonate with at least one acidic agent to obtain a pH of less than about 7.0.

14. The method of claim 13, wherein said pH is from about 3.5 to about 6.0.

5 15. The method of claim 13, wherein said pH is about 6.

16. The method of claim 13, further comprising, after titrating, filtering off said sodium zirconium carbonate and washing said sodium zirconium carbonate.

17. The method of claim 16, further comprising, after washing, drying said sodium zirconium carbonate.

10 18. The method of claim 17, wherein said drying occurs for a sufficient time to form a free flowing powder.

19. The method of claim 17, wherein after said drying, said sodium zirconium carbonate has a moisture content of from about 10% LOD to about 60% LOD.

15 20. The method of claim 19, wherein said moisture content is from about 30% LOD to about 35% LOD.

21. The method of claim 18, wherein said sodium zirconium carbonate has an average particle size of from about 30 microns to about 50 microns.

22. The method of claim 1, wherein said heating occurs at a heating rate of from about 0.5 °F to about 1 °F/minute until boiling temperature of said mixture.

20 23. A method of making sodium zirconium carbonate comprising mixing zirconium oxychloride with soda ash and agitating to form a solution mixture at ambient temperatures; heating said mixture of zirconium oxychloride and soda ash at a sufficient temperature and for a sufficient time to form said sodium zirconium carbonate, wherein said sufficient temperature is the boiling temperature of the mixture of zirconium oxychloride

and soda ash; after said heating, filtering off the sodium zirconium carbonate; after filtering, washing any chloride or any impurities from said sodium zirconium carbonate; titrating an alkaline slurry comprising said sodium zirconium carbonate with at least one acidic agent to obtain a pH of less than about 7.0; after titrating, filtering off said sodium zirconium carbonate and washing said sodium zirconium carbonate; and after washing, drying said sodium zirconium carbonate.

24. A method of making a zirconium basic carbonate comprising titrating an aqueous slurry of sodium zirconium carbonate to a pH of from about 3.5 to about 4.0 with a acidic agent, wherein said sodium zirconium carbonate has a moisture content of from about 15% to about 25 % LOD in solid form;

and washing said aqueous slurry containing the zirconium basic carbonate with water.

25. The method of claim 24, further comprising recovering said zirconium basic chloride wet powder from said slurry.

26. The method of claim 25, wherein said recovery occurs by a vacuum filtration.

27. The method of claim 25, wherein said recovery occurs by centrifuging.

28. A zirconium basic carbonate having:

Na^+ of less than about 1000 ppm;

a ZrO_2 wt% of from about 35 wt% to about 40 wt%;

and a CO_3^{2-} of from about 8 wt% to about 10 wt%, based on the weight of the zirconium basic carbonate.

29. The zirconium basic carbonate of claim 28, wherein said zirconium basic carbonate has about 0 wt% SO_4^{2-} and about 0 wt% Cl^- .

30. The method of claim 24, wherein said sodium zirconium carbonate is formed by heating a mixture of zirconium oxychloride and soda ash at a sufficient temperature and for a sufficient time to form said sodium zirconium carbonate.

31. The method of claim 30, further comprising, after heating, filtering off the sodium zirconium carbonate and washing any chloride or impurities from said sodium zirconium carbonate;

titrating an alkaline slurry comprising said sodium zirconium carbonate with at least one acidic agent to obtain a pH below about 7.0;

filtering off said sodium zirconium carbonate and washing said sodium zirconium carbonate; and

drying said sodium zirconium carbonate for a sufficient time to obtain a free flowing powder;

wherein after drying, sodium zirconium carbonate has a moisture content of from about 10% LOD to about 60% LOD.

32. A sodium zirconium carbonate comprising from about 2 wt% to about 5 wt% Na^+ ;

from about 44 wt% to about 50 wt% ZrO_2 ;

from about 12 wt% to about 18 wt% CO_3^{2-} ; and

from about 32 wt% to about 35 wt% H_2O , based on the weight of the sodium zirconium carbonate.

33. The sodium zirconium carbonate of claim 32, wherein said sodium zirconium carbonate satisfies ANSI/AAMI RD-5-1992 standard on extractable toxic impurities.

34. The sodium zirconium carbonate of claim 32, wherein said sodium

zirconium carbonate satisfies at least one of the following characteristics:

a phosphate adsorption having a minimum capacity of from about 30 to about 35 mg/PO₄-P/gm SCZ;

a minimum HCO₃⁻ content of from about 2 to about 4 mEq HCO₃⁻ gm SCZ;

5 a leachable Na⁺ content of from about 1.5 to about 2.0 mEq Na⁺/gm SCZ;

or a pH range of titrated sodium zirconium carbonate of from about 6 to about 7.

35. A method of making zirconium phosphate comprising treating sodium zirconium carbonate with caustic soda to form alkaline hydrous zirconium oxide;

10 heating a slurry comprising said alkaline hydrous zirconium oxide and adding phosphoric acid; and

recovering said acid zirconium phosphate.

36. The method of claim 35, further comprising titrating an aqueous slurry of said acid zirconium phosphate with caustic soda to obtain a pH of from about 5 to about 6
15 and;

recovering said titrated zirconium phosphate.

37. The method of claim 36, further comprising filtering said titrated zirconium phosphate and washing the filtered zirconium phosphate.

38. The method of claim 37, further comprising drying said zirconium phosphate
20 to obtain a free flowing powder.

39. The method of claim 38, wherein said zirconium phosphate has a moisture level of from about 12% to about 18% LOD.

40. The method of claim 37, wherein said the washing of the titrated zirconium phosphate is with RO water sufficient to obtain a 300 ppm or less Total Dissolved Solid and

minimize leachable Na^+ .

41. The method of claim 36, wherein said caustic soda is a 50% caustic soda.

42. The method of claim 35, wherein said heating is at a temperature of from about 180 °F to about 185 °F for one hour.

5 43. The method of claim 35, wherein said sodium zirconium carbonate is obtained from heating zirconium oxychloride with soda ash at a sufficient temperature and for a sufficient time to form the sodium zirconium carbonate.

44. The method of claim 43, wherein said heating of zirconium oxychloride is at a temperature of from about 150 °F to about 250 °F.

10 45. The method of claim 43, further comprising, after heating of the zirconium oxychloride with soda ash to form the sodium zirconium carbonate, filtering off and washing said sodium zirconium carbonate to remove any chloride or impurities from said sodium zirconium carbonate.

46. A zirconium phosphate having a Na^+ of from about 4 to about 6%;
15 a ZrO_2 wt% of from about 34 wt% to about 37 wt%;
a PO_4 wt% of from about 41 wt% to about 43 wt%; and
a H_2O wt% of from about 14 wt% to about 18 wt%, based on the weight of the zirconium phosphate.

47. The zirconium phosphate of claim 46, wherein said zirconium phosphate has
20 at least one of the following characteristics:

a) an adsorption capacity for ammonia of from about 30 mg $\text{NH}_4\text{N/gm}$ ZrP to about 35 mg $\text{NH}_4\text{N/gm}$ ZrP;

an adsorption capacity for Ca^{2+} of from about 3 mEq Ca^{2+}/gm ZrP to about 5 mEq Ca^{2+}/gm ZrP;

an adsorption capacity for Mg^{2+} of from about 2 mEq Mg^{2+} /gm ZrP to about 3 mEq Mg^{2+} /gm ZrP; and

an adsorption capacity for toxic heavy metals of from about 5 mEq HM/gm ZrP to about 7 mEq HM/gm ZrP;

5 b) a Na^+ content of from about 2 mEq Na^+ /gm ZrP to about 3 mEq Na^+ /gm ZrP at a pH of from about 5.75 to about 6;

 c) a minimum leachable PO_4^{3-} of less than about 0.05 mg PO_4^{3-} /gm ZrP; or

 d) satisfying ANSI/AAMI RD-5-1992 standard on extractable toxic impurities.

48. The zirconium phosphate of claim 46, wherein said zirconium phosphate has
10 no residual sulfate or chloride.

49. The zirconium phosphate of claim 46, wherein said zirconium phosphate has less than 0.01% sulfate, chloride, or both.

50. The zirconium phosphate of claim 46, wherein said zirconium phosphate is H_2O has a pH of from about 6 to about 7.

15 51. The zirconium phosphate of claim 46, wherein said zirconium phosphate has an average grain size of from about 30 to about 40 microns.